

# MGA-31816

## 0.1 W High Linearity Driver Amplifier



## Data Sheet

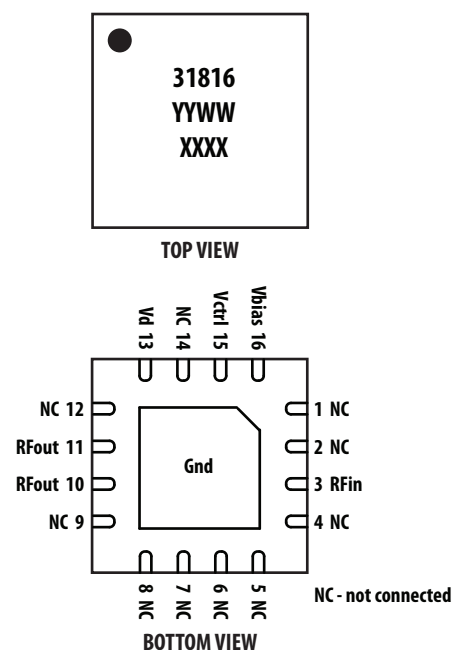
### Description

Avago Technologies MGA-31816 is a high linearity driver MMIC Amplifier housed in a standard QFN 3X3 16 lead plastic package. It features high gain, low operating current, good noise figure with good input and output return loss. Power consumption can be further reduced by reducing the quiescent bias current using two external bias resistors. The device can be easily matched at different frequencies to obtain optimal linearity performance at those frequencies.

MGA-31816 is especially ideal for 50  $\Omega$  wireless infrastructure application operating from 1.5 GHz to 4 GHz frequency range applications. With the high linearity, excellent gain flatness and low noise figure the MGA-31816 may be utilized as a driver amplifier in the transmit chain and as a second stage LNA in the receiver chain.

This device uses Avago Technologies proprietary 0.25  $\mu\text{m}$  GaAs Enhancement mode PHEMT process.

### Pin connections and Package Marking



Notes:  
 Package marking provides orientation and identification  
 "31816" = Device Part Number  
 "YYWW" = Work Week and Year of manufacturing  
 "XXXX" = Last 4 digit of Lot Number

### Features

- Very high linearity at low DC bias power <sup>[1]</sup>
- High Gain with good gain flatness
- Good Noise Figure
- ROHS compliant
- Halogen free
- Advanced enhancement-mode PHEMT Technology
- QFN 3X3 16-Lead standard package
- Lead-free MSL1

### Specifications

At 1900 MHz,  $V_{dd} = 5\text{ V}$ ,  $I_{dd} = 60\text{ mA (typ)}$  @ 25° C

- OIP3 = 40.2 dBm
- Noise Figure = 1.56 dB
- Gain = 19.4 dB
- P1dB = 20.7 dBm

Note:

1. The MGA-31816 has a superior LFOM of 15.8 dB. Linearity Figure of Merit (LFOM) is essentially OIP3 divided by DC bias power.



**Attention: Observe precautions for handling electrostatic sensitive devices.**  
 ESD Machine Model = 60 V  
 ESD Human Body Model = 300 V  
 Refer to Avago Application Note A004R:  
 Electrostatic Discharge, Damage and Control.

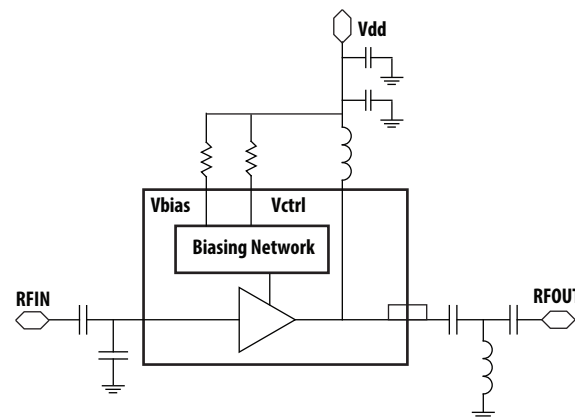


Figure 1. Simplified Application Circuit

**Table 1. MGA-31816 Absolute Maximum Rating** <sup>[1]</sup> ( $T_A = 25^\circ\text{C}$ )

| Symbol           | Parameter                        | Units            | Absolute Maximum |
|------------------|----------------------------------|------------------|------------------|
| $V_{dd, \max}$   | Drain Voltage                    | V                | 5.5              |
| $V_{bias, \max}$ | Bias Voltage                     | V                | 5.5              |
| $V_{ctrl, \max}$ | Control Voltage                  | V                | 5.5              |
| $P_d$            | Power Dissipation <sup>[2]</sup> | mW               | 605              |
| $P_{in}$         | CW RF Input Power                | dBm              | 24               |
| $T_j$            | Junction Temperature             | $^\circ\text{C}$ | 150              |
| $T_{stg}$        | Storage Temperature              | $^\circ\text{C}$ | -65 to 150       |
| $T_{amb}$        | Ambient Temperature              | $^\circ\text{C}$ | -40 to 85        |

**Thermal Resistance****Thermal Resistance** <sup>[3]</sup>**( $V_{dd} = 5.0\text{ V}$ ,  $T_C = 85^\circ\text{C}$ )  $\theta_{jc} = 65.8^\circ\text{C/W}$** 

Notes:

1. Operation of this device in excess of any of these limits may cause permanent damage
2. Source lead temperature is  $25^\circ\text{C}$ . Derate  $15.2\text{ mW}/^\circ\text{C}$  for  $T_L > 126.0^\circ\text{C}$ .
3. Thermal resistance measured using  $150^\circ\text{C}$  Infra-Red Microscopy Technique.

**Table 2. MGA-31816 Electrical Specification** <sup>[1]</sup> $T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ , unless noted

| Symbol                 | Parameter and Test Condition         | Frequency                        | Units | Min. | Typ.                 | Max. |
|------------------------|--------------------------------------|----------------------------------|-------|------|----------------------|------|
| $I_{ds}$               | Quiescent Current                    | 1900 MHz<br>2600 MHz<br>3500 MHz | mA    | 37   | 60<br>59<br>65       | 83   |
| NF                     | Noise Figure                         | 1900 MHz<br>2600 MHz<br>3500 MHz | dB    | –    | 1.56<br>1.6<br>2.2   | 2.4  |
| Gain                   | Gain                                 | 1900 MHz<br>2600 MHz<br>3500 MHz | dB    | 18   | 19.4<br>18.8<br>18.5 | 21   |
| OIP3 <sup>[2]</sup>    | Output Third Order Intercept Point   | 1900 MHz<br>2600 MHz<br>3500 MHz | dBm   | 37   | 40.2<br>39.4<br>39.2 | –    |
| LFOM <sup>[2, 3]</sup> | Linearity Figure of Merit            | 1900 MHz<br>2600 MHz<br>3500 MHz | dB    | –    | 15.5<br>14.8<br>14.1 | –    |
| P1dB                   | Output Power at 1dB Gain Compression | 1900 MHz<br>2600 MHz<br>3500 MHz | dBm   | 19   | 20.7<br>19.9<br>19.3 | –    |
| PAE                    | Power Added Efficiency at P1dB       | 1900 MHz<br>2600 MHz<br>3500 MHz | %     | –    | 38.6<br>32.6<br>24.6 | –    |
| IRL                    | Input Return Loss                    | 1900 MHz<br>2600 MHz<br>3500 MHz | dB    | –    | 17.6<br>20.8<br>11.3 | –    |
| ORL                    | Output Return Loss                   | 1900 MHz<br>2600 MHz<br>3500 MHz | dB    | –    | 10.2<br>10<br>14.7   | –    |
| ISOL                   | Isolation                            | 1900 MHz<br>2600 MHz<br>3500 MHz | dB    | –    | 25.7<br>26.5<br>28.1 | –    |

Notes:

1. Measurements obtained from test circuits detailed in Figures 46 and 47 and Table 3.
2. OIP3 test condition:  $F1 - F2 = 1\text{ MHz}$ , with input power of  $-13\text{ dBm}$  per tone measured at worst case side band.
3. LFOM is defined as  $\text{LFOM} = \text{OIP3 (in dBm)} - P_{DC} \text{ (in dBm)}$ . It is a measure of the linearity of an amplifier per unit of DC power consumed.
4. Demoboard tuned to best OIP3 with minimum over temperature drift.

## MGA-31816 Consistency Distribution Chart [1, 2]

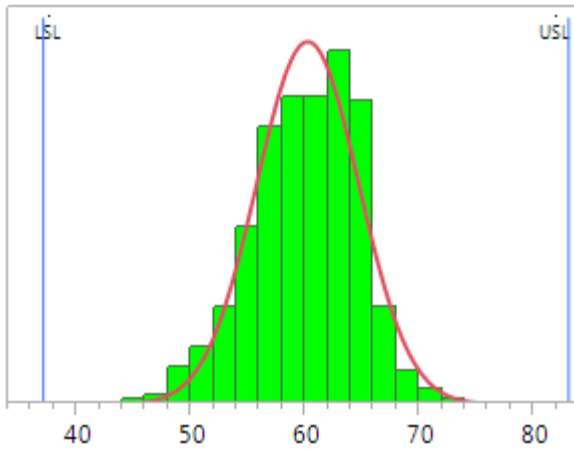


Figure 2.  $I_{dd}$  @ 1900 MHz; LSL = 37 mA, Nominal = 60 mA, USL = 83 mA

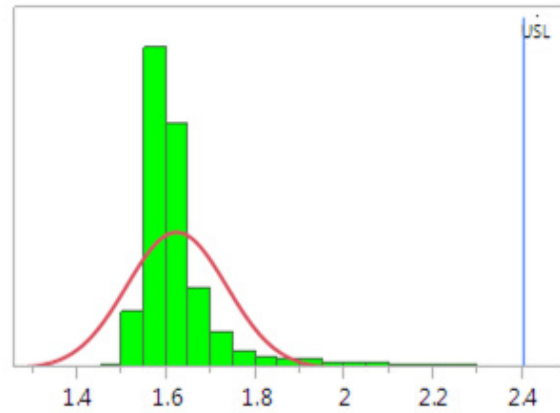


Figure 3. NF @ 1900 MHz; Nominal = 1.56 dB, USL = 2.4 dB

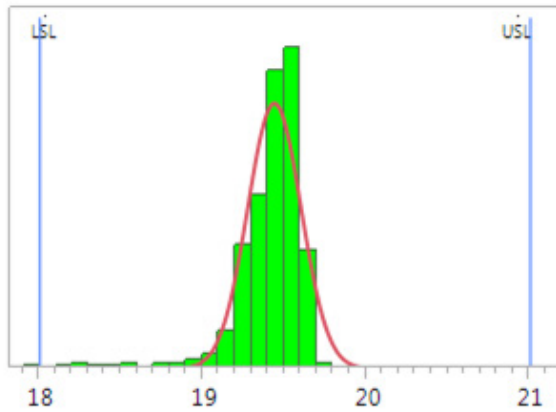


Figure 4. Gain @ 1900 MHz; LSL = 18 dB, Nominal = 19.4 dB, USL = 21 dB

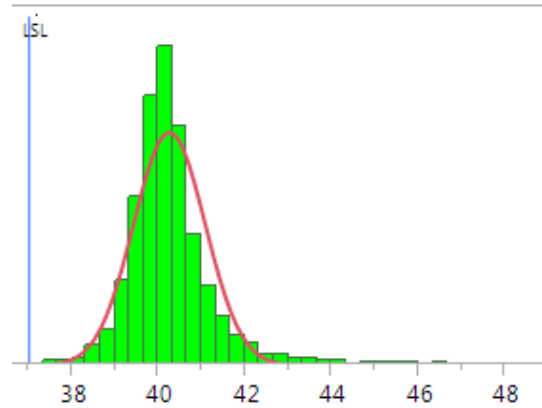


Figure 5. OIP3 @ 1900 MHz; Nominal = 40.2 dBm, LSL = 37 dBm

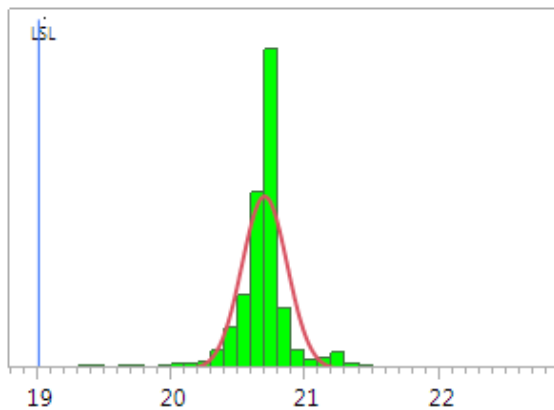


Figure 6. P1dB @ 1900 MHz; Nominal = 20.7 dBm, LSL = 19 dBm

### Notes:

1. Data sample size is 4000 samples taken from 4 different wafers and 2 different lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
2. Measurements are made on production test board which represents a trade-off between optimal Gain, NF, OIP3 and OP1dB. Circuit losses have been de-embedded from actual measurements.

## MGA-31816 Typical Performance Data for 1.9 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

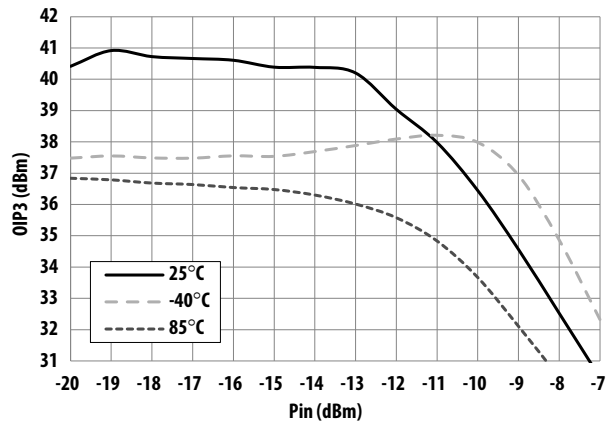


Figure 7. OIP3 vs Pin and Temperature

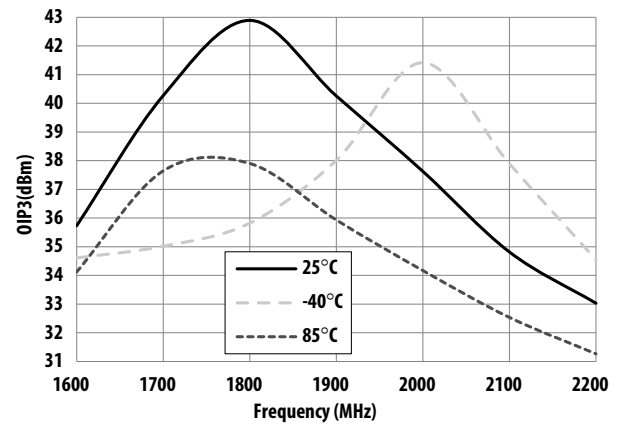


Figure 8. OIP3 vs Frequency and Temperature

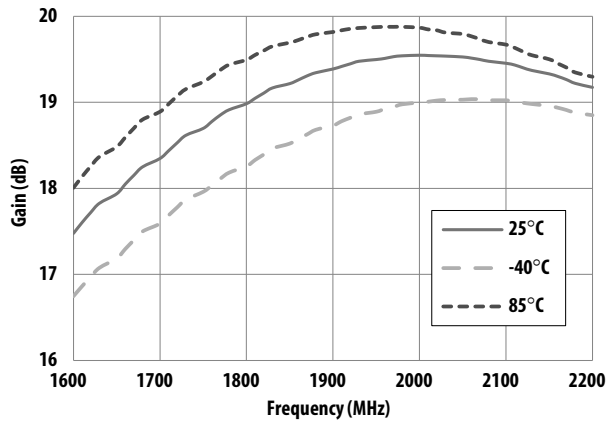


Figure 9. Gain vs Frequency and Temperature

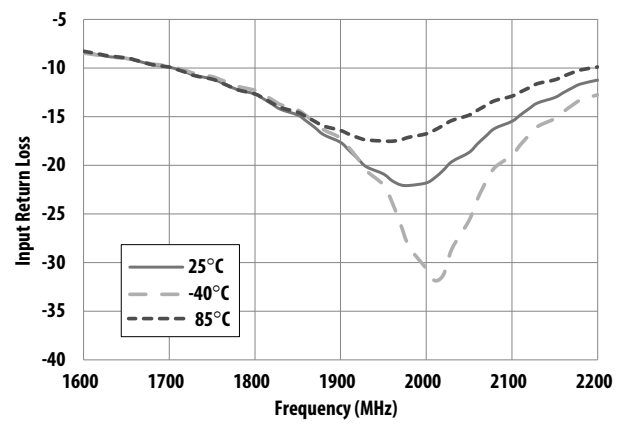


Figure 10. IRL vs Frequency and Temperature

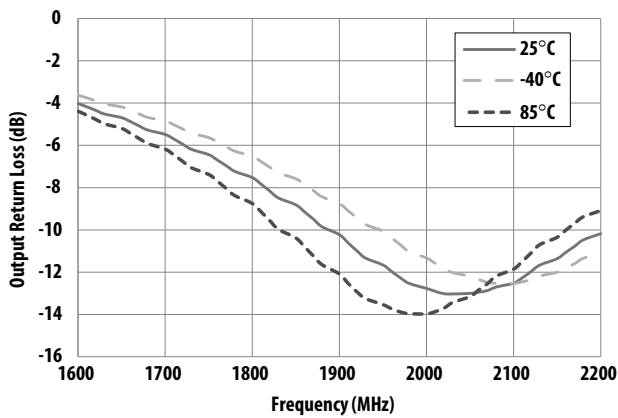


Figure 11. ORL vs Frequency and Temperature

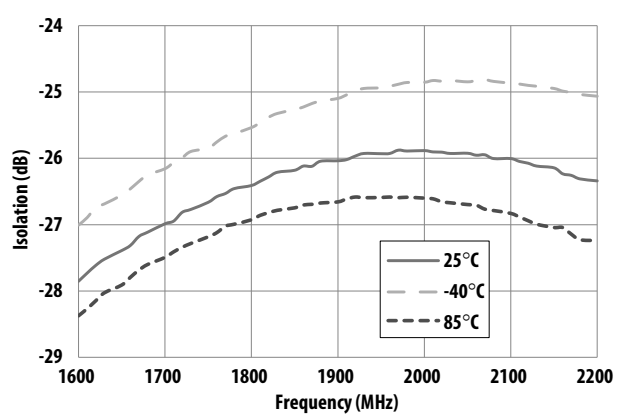


Figure 12. Isolation vs Frequency and Temperature

## MGA-31816 Application Circuit Data for 1.9 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

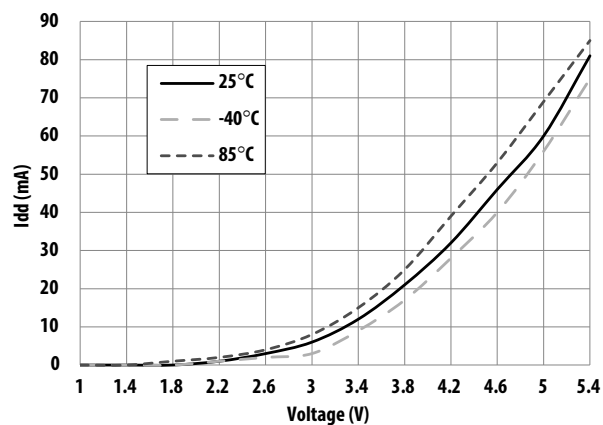


Figure 13. P1dB vs Frequency and Temperature

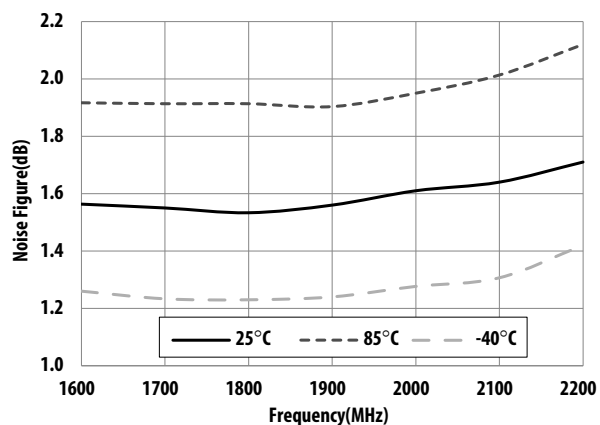


Figure 14. Noise Figure vs Frequency and Temperature

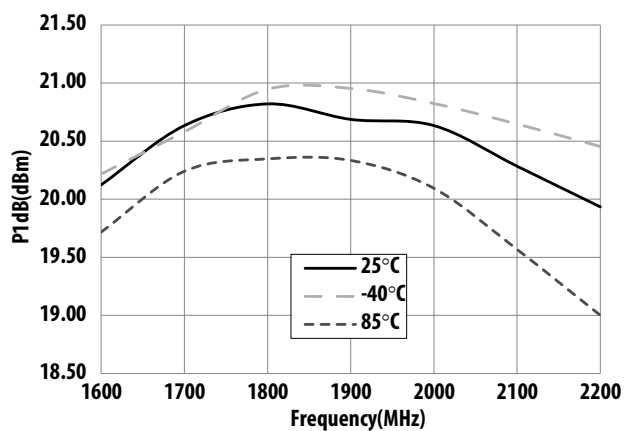


Figure 15. Current vs Voltage and Temperature

## MGA-31816 Application Circuit Data for 1.9 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{DD} = 5.0\text{V}$ ,  $I_{DD} = 60\text{mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

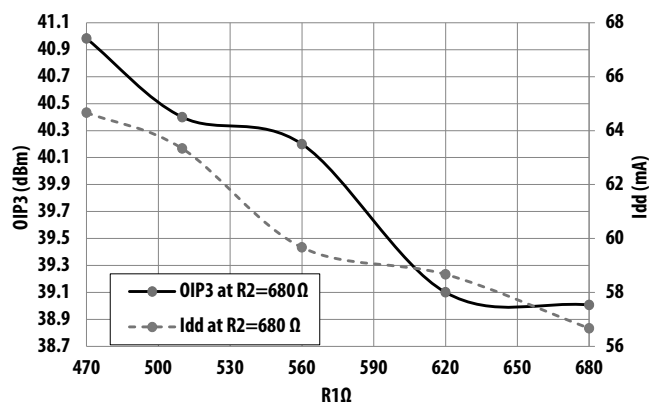


Figure 16. OIP3 and Quiescent Current with different R1 <sup>[1]</sup>

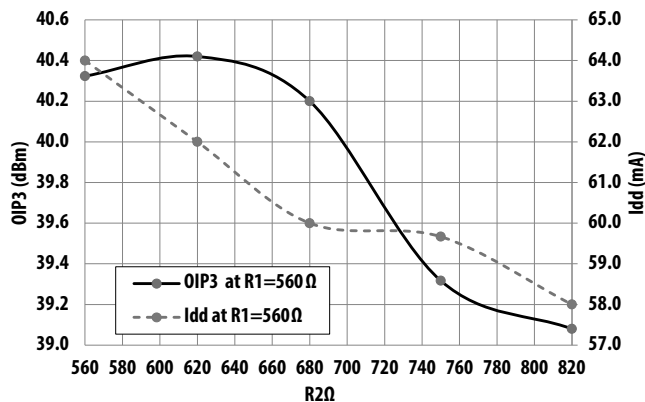


Figure 17. OIP3 and Quiescent Current with different R2 <sup>[1]</sup>

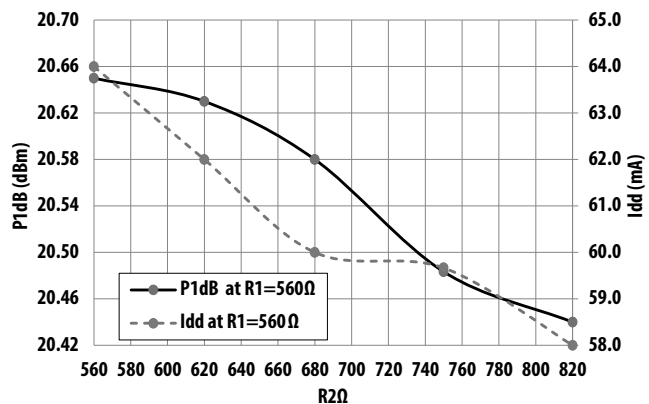


Figure 18. P1dB and Quiescent Current with different R1 <sup>[1]</sup>

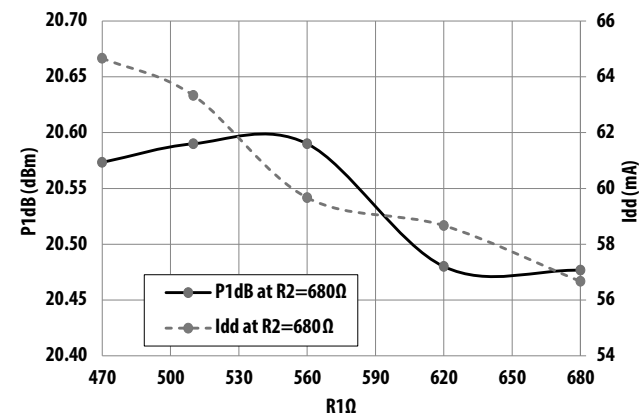


Figure 19. P1dB and Quiescent Current with different R2 <sup>[1]</sup>

Note:

1.  $V_{bias}$  and  $V_{ctrl}$  can be externally controlled by change external biasing resistors  $R1 = R_{bias}$  and  $R2 = R_{ctrl}$  (as shown in Fig. 46).

## MGA-31816 Application Circuit Data for 2.6 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

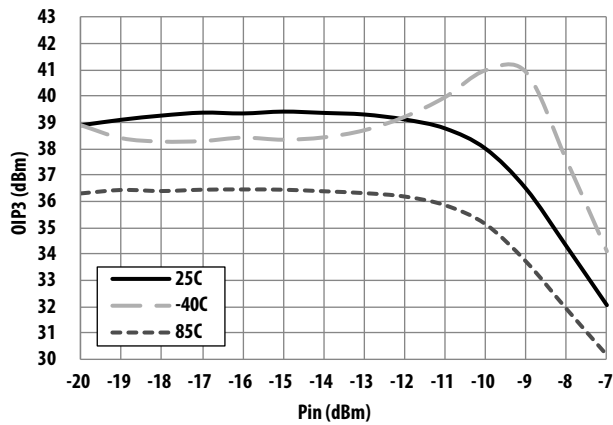


Figure 20. OIP3 vs Pin and Temperature

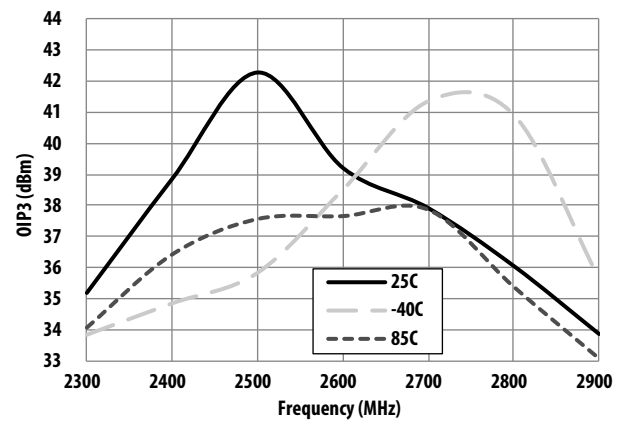


Figure 21. OIP3 vs Frequency and Temperature

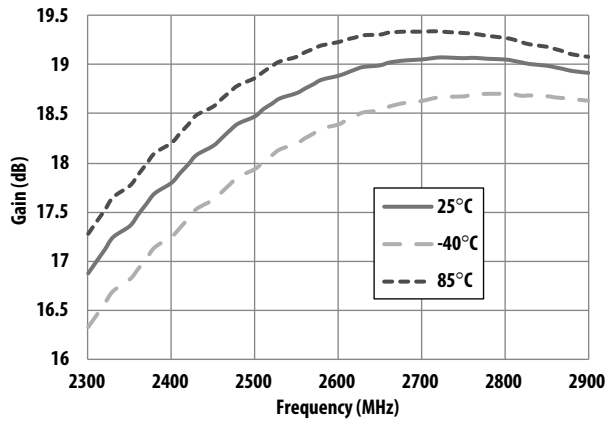


Figure 22. Gain vs Frequency and Temperature

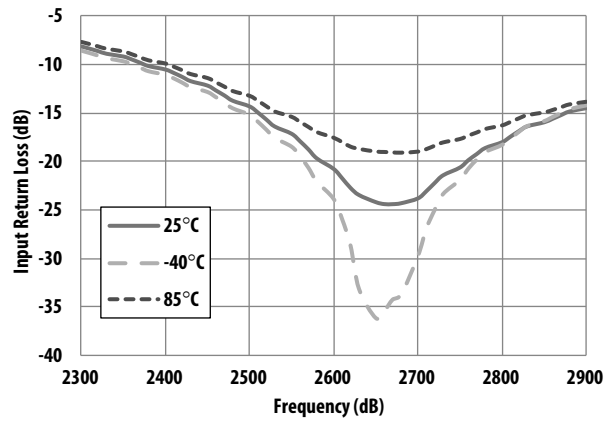


Figure 23. IRL vs Frequency and Temperature

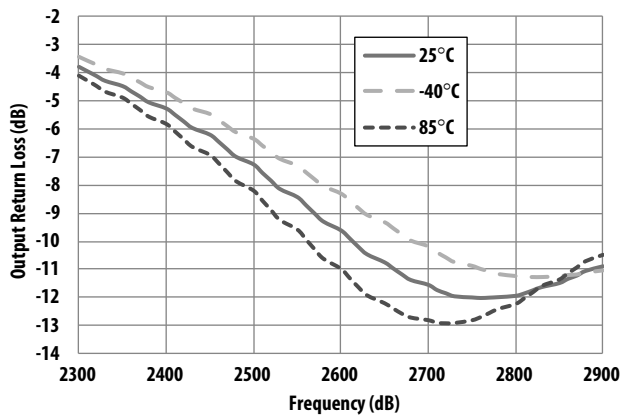


Figure 24. ORL vs Frequency and Temperature

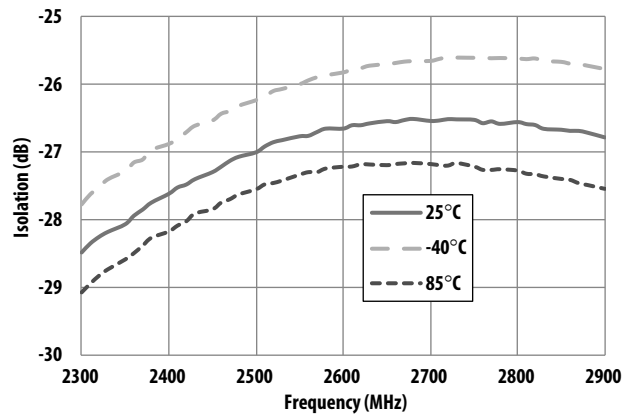


Figure 25. Isolation vs Frequency and Temperature

## MGA-31816 Application Circuit Data for 2.6 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

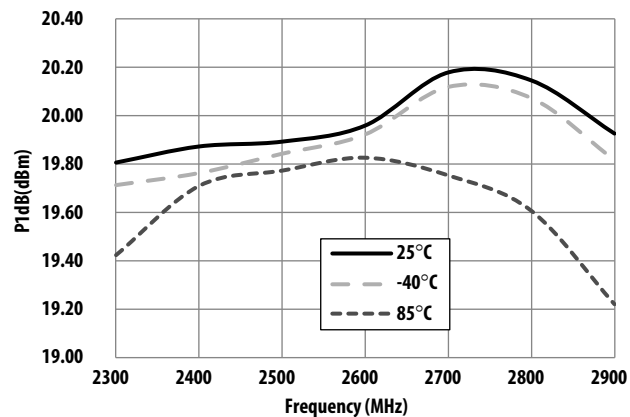


Figure 26. P1dB vs Frequency and Temperature

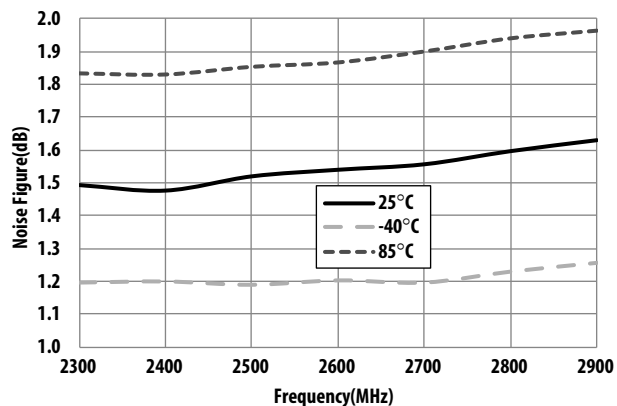


Figure 27. Noise Figure vs Frequency and Temperature

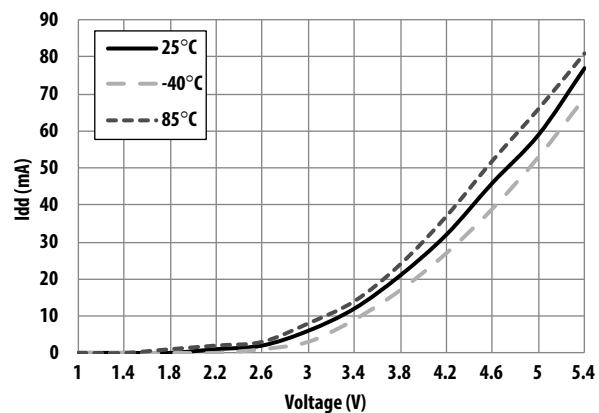


Figure 28. Current vs Voltage and Temperature

## MGA-31816 Application Circuit Data for 2.6 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

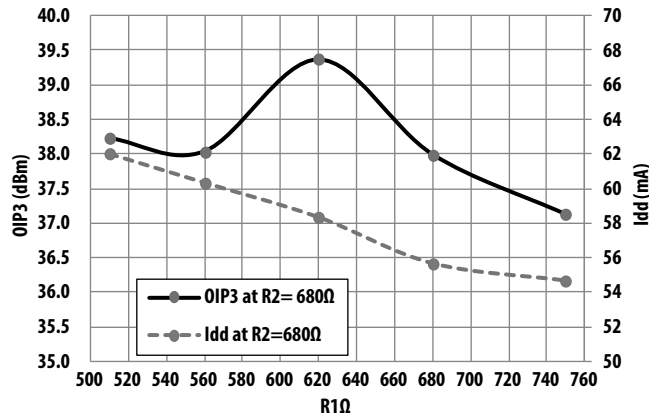


Figure 29. OIP3 and Quiescent Current with different R1 <sup>[1]</sup>

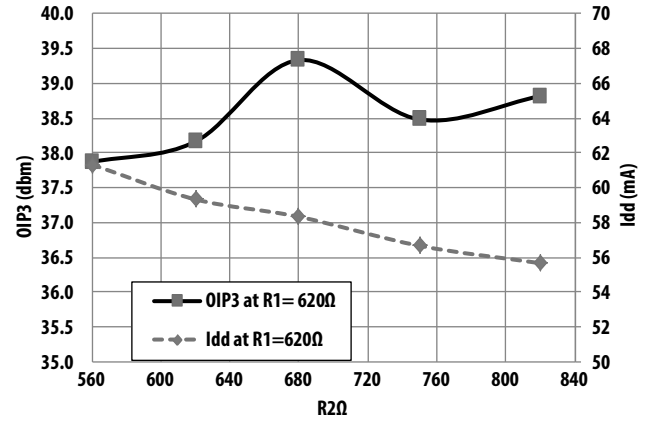


Figure 30. OIP3 and Quiescent Current with different R2 <sup>[1]</sup>

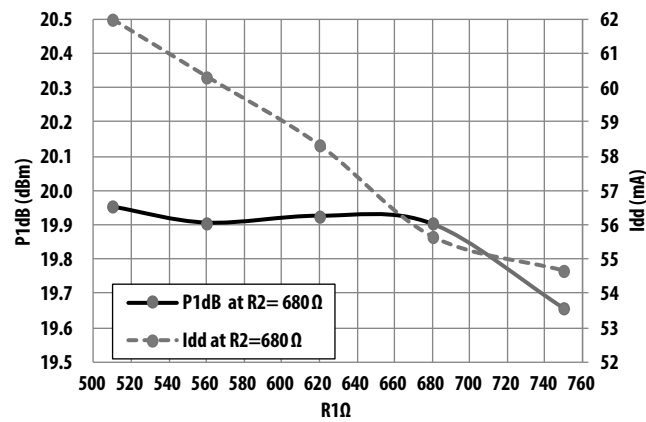


Figure 31. P1dB and Quiescent Current with different R1 <sup>[1]</sup>

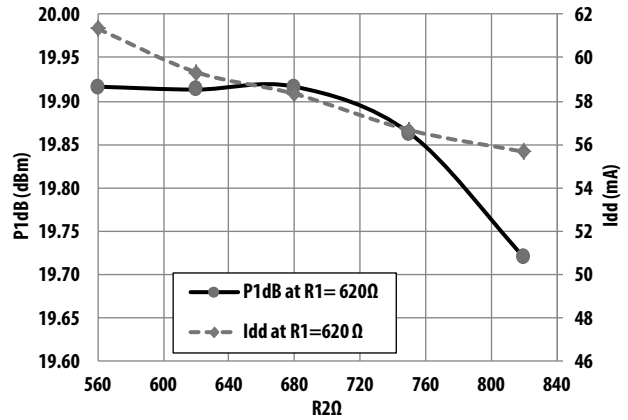


Figure 32. P1dB and Quiescent Current with different R2 <sup>[1]</sup>

Note:

1.  $V_{bias}$  and  $V_{ctrl}$  can be externally controlled by change external biasing resistors  $R1 = R_{bias}$  and  $R2 = R_{ctrl}$  (as shown in Fig. 46).

## MGA-31816 Application Circuit Data for 3.5 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

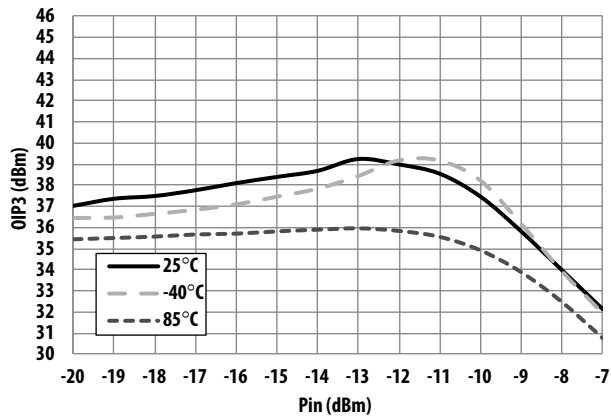


Figure 33. OIP3 vs Pin and Temperature

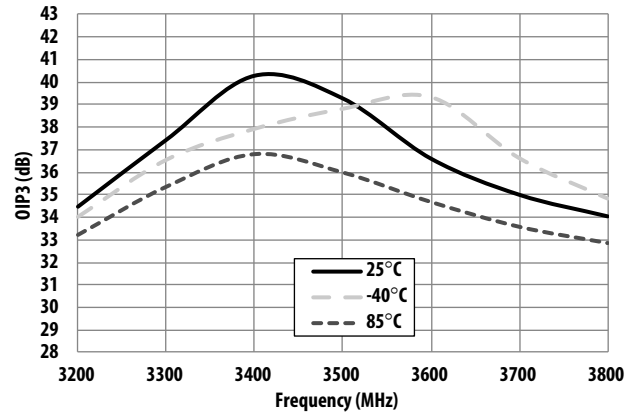


Figure 34. OIP3 vs Frequency and Temperature

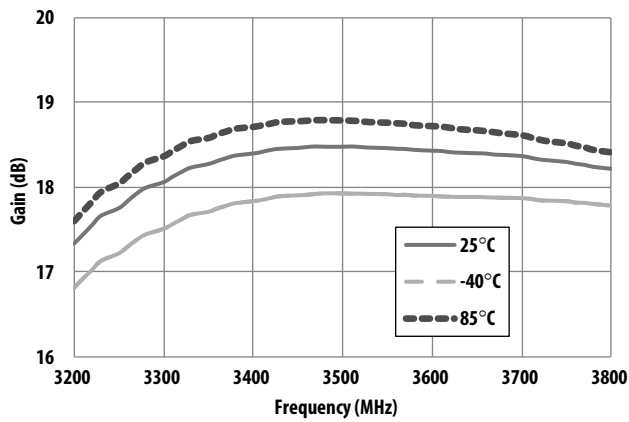


Figure 35. Gain vs Frequency and Temperature

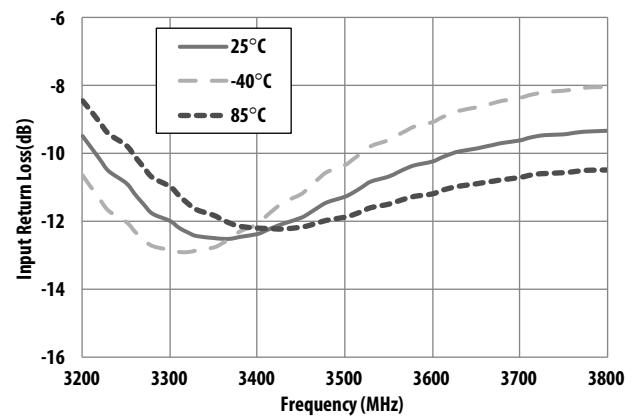


Figure 36. IRL vs Frequency and Temperature

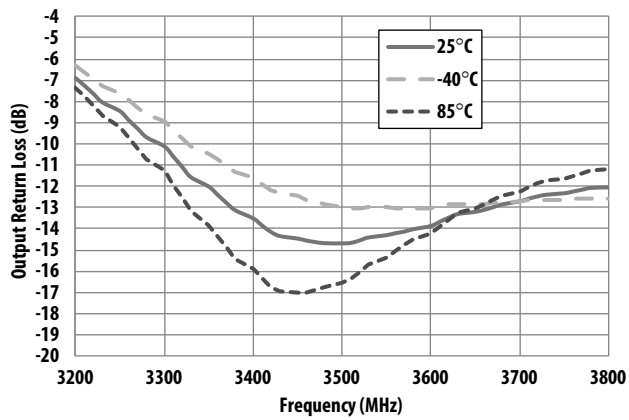


Figure 37. ORL vs Frequency and Temperature

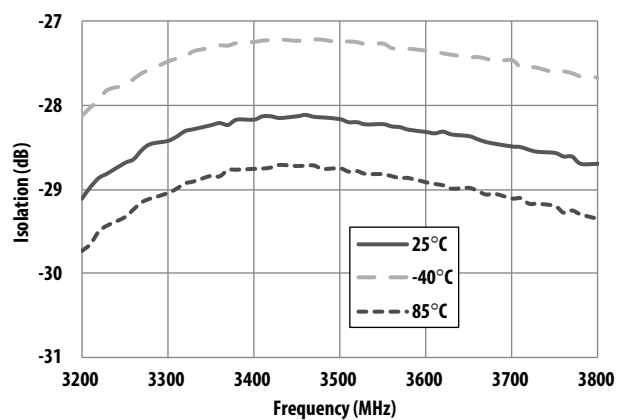


Figure 38. Isolation vs Frequency and Temperature

## MGA-31816 Application Circuit Data for 3.5 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{V}$ ,  $I_{dd} = 60\text{mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

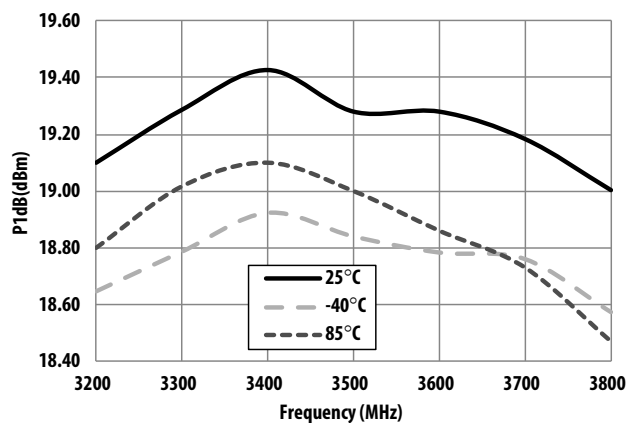


Figure 39. P1dB vs Frequency and Temperature

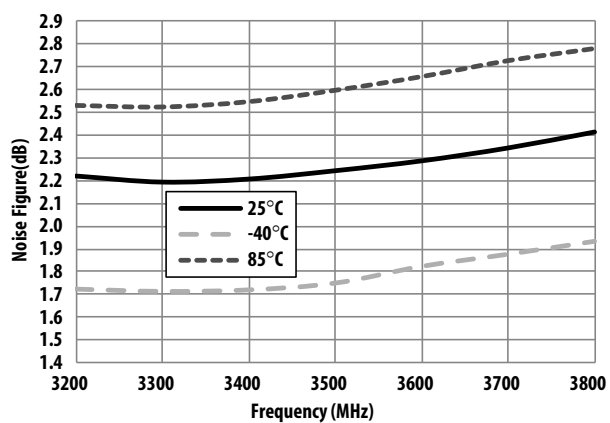


Figure 40. Noise Figure vs Frequency and Temperature

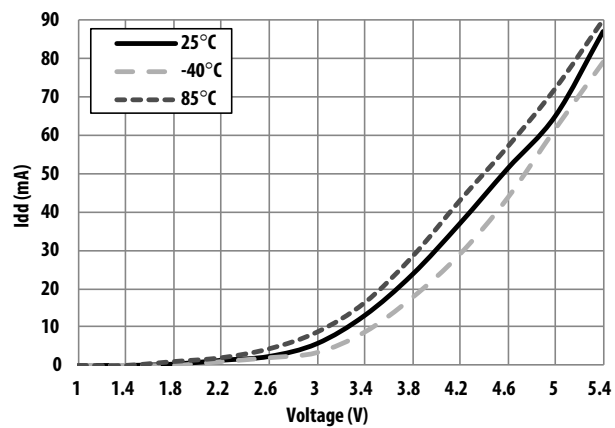


Figure 41. Current vs Voltage and Temperature

## MGA-31816 Application Circuit Data for 3.5 GHz

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{V}$ ,  $I_{dd} = 60\text{mA}$  (Based on BOM in Table 3, tuned for optimal linearity with over temperature)

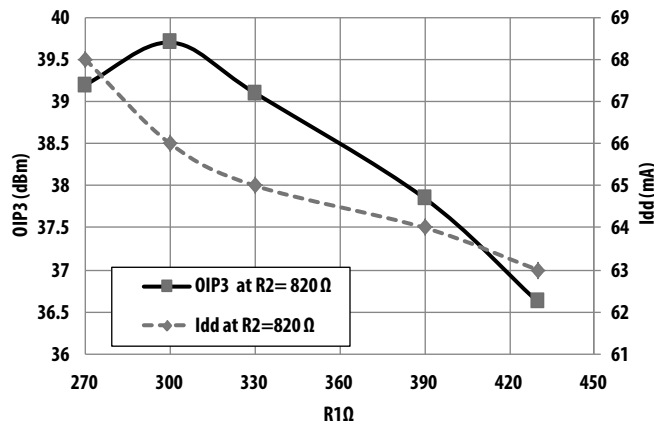


Figure 42. OIP3 and Quiescent Current with different R1 <sup>[1]</sup>

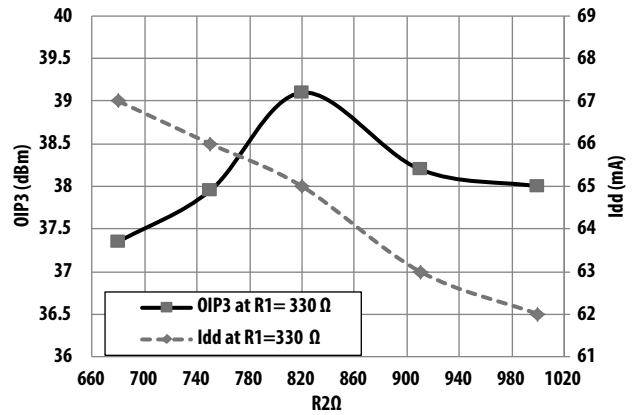


Figure 43. OIP3 and Quiescent Current with different R2 <sup>[1]</sup>

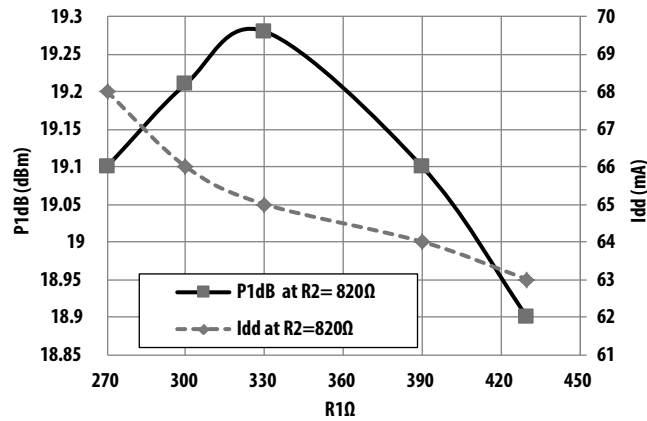


Figure 44. P1dB and Quiescent Current with different R1 <sup>[1]</sup>

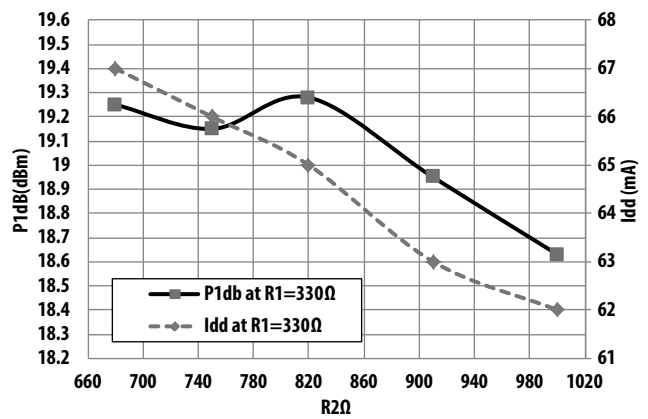


Figure 45. P1dB and Quiescent Current with different R2 <sup>[1]</sup>

Note:

1.  $V_{bias}$  and  $V_{ctrl}$  can be externally controlled by change external biasing resistors  $R1 = R_{bias}$  and  $R2 = R_{ctrl}$  (as shown in Fig. 46).

## Application Circuit Description and Layout

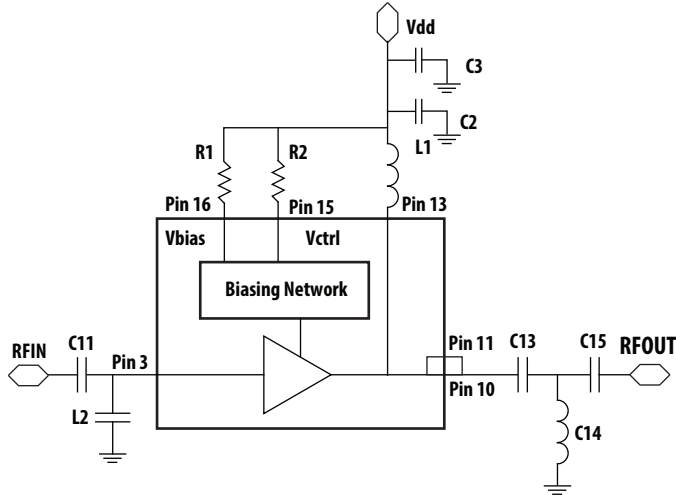


Figure 46. Circuit Diagram

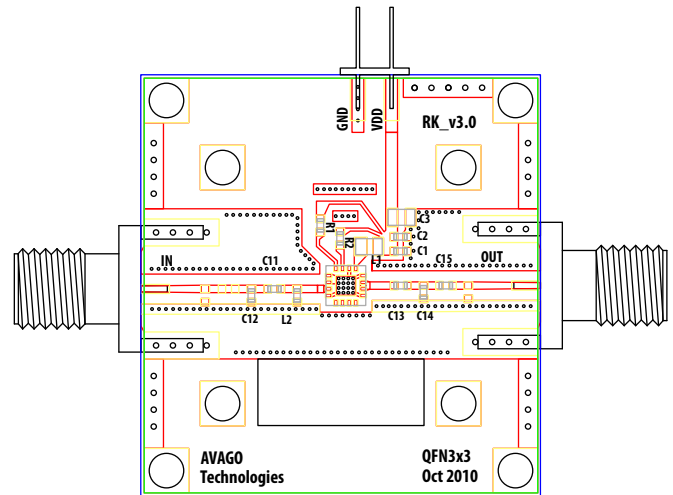


Figure 47. Demoboard

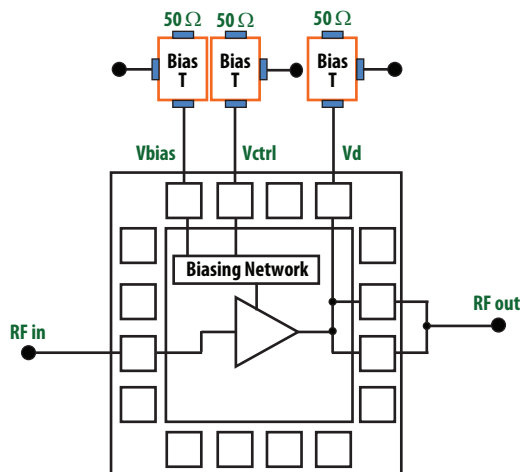
Table 3. Bill of Materials – Tuned for optimal linearity performance at different frequencies

| Circuit Symbol | Size | Description  |              |              |              |              |              |
|----------------|------|--------------|--------------|--------------|--------------|--------------|--------------|
|                |      | For 1900 MHz |              | For 2600 MHz |              | For 3500 MHz |              |
|                |      | Value        | Manufacturer | Value        | Manufacturer | Value        | Manufacturer |
| C2             | 0402 | 18 pF        | Murata       | 12 pF        | Murata       | 5 pF         | Murata       |
| C3             | 0603 | 2.2 $\mu$ F  | Murata       | 2.2 $\mu$ F  | Murata       | 2.2 $\mu$ F  | Murata       |
| C11            | 0402 | NR           | NR           | 5 pF         | Murata       | 1 pF         | Murata       |
| C13            | 0402 | 1.3 pF       | Murata       | 0.75 pF      | Murata       | 2.7 pF       | Murata       |
| C14            | 0402 | 0.5 pF       | Murata       | NR           | NR           | 1.8 nH       | Murata       |
| C15            | 0402 | NR           | NR           | NR           | NR           | 0.7 pF       | Murata       |
| L1             | 0402 | 1.8 nH       | Murata       | 0 $\Omega$   | KOA          | 0 $\Omega$   | KOA          |
| L2             | 0402 | 1.5 pF       | Murata       | 0.8 pF       | Murata       | 0.6 pF       | Murata       |
| R1 [1]         | 0402 | 560 $\Omega$ | KOA          | 620 $\Omega$ | KOA          | 330 $\Omega$ | KOA          |
| R2 [1]         | 0402 | 680 $\Omega$ | KOA          | 680 $\Omega$ | KOA          | 820 $\Omega$ | KOA          |

Notes:

NR – Not required in actual PCB design

1. R1 and R2 can be varied to bias Vbias and Vctrl which will provide flexibility to have the product operates at desirable Idd, LFOM, OIP3 drift across temperature and P1dB.
2. Capacitor is use at L2 and inductor is use at C14 for 3500MHz.



Note:

1. Measurements are conducted on 0.010 inch thick ROGER 4350. The input reference plane is at the end of the RFin pin and the output reference plane is at the end of the RFout pin as shown in Figure 48.

Figure 48. Circuit to measure de-embedded S-parameters and Noise Parameter in Table 4 and 5.

**Table 4. MGA-31816 Typical Scattering Parameters**

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$ ,  $Z_0 = 50\ \Omega$  (Data is de-embedded to the RFin & RFout pins on package. Measurements were made with Bias-T at  $V_{dd}$ ,  $V_{ctrl}$  and  $V_{bias}$  in Figure 48)

| Freq<br>GHz | S11<br>Mag. | S11<br>dB | S11<br>Ang. | S21<br>Mag. | S21<br>dB | S21<br>Ang. | S12<br>Mag. | S12<br>dB | S12<br>Ang. | S22<br>Mag. | S22<br>dB | S22<br>Ang. | K Factor |
|-------------|-------------|-----------|-------------|-------------|-----------|-------------|-------------|-----------|-------------|-------------|-----------|-------------|----------|
| 0.10        | 0.919       | -0.7      | 163.7       | 0.250       | -12.0     | -79.9       | 0.001       | -57.2     | 143.7       | 0.781       | -2.2      | 152.0       | 87.589   |
| 0.20        | 0.907       | -0.8      | 147.4       | 0.776       | -2.2      | -80.7       | 0.005       | -46.8     | 98.7        | 0.754       | -2.5      | 122.7       | 11.054   |
| 0.30        | 0.890       | -1.0      | 131.3       | 1.603       | 4.1       | -95.7       | 0.008       | -41.5     | 88.2        | 0.721       | -2.9      | 93.1        | 4.096    |
| 0.40        | 0.862       | -1.3      | 114.9       | 2.659       | 8.5       | -115.4      | 0.014       | -36.9     | 69.8        | 0.673       | -3.4      | 63.1        | 2.276    |
| 0.50        | 0.823       | -1.7      | 98.6        | 3.832       | 11.7      | -137.1      | 0.021       | -33.6     | 50.8        | 0.614       | -4.2      | 32.3        | 1.693    |
| 0.60        | 0.773       | -2.2      | 82.4        | 5.011       | 14.0      | -159.4      | 0.027       | -31.3     | 30.9        | 0.550       | -5.2      | 1.5         | 1.452    |
| 0.70        | 0.719       | -2.9      | 67.3        | 6.091       | 15.7      | 178.8       | 0.033       | -29.5     | 10.8        | 0.486       | -6.3      | -29.1       | 1.315    |
| 0.80        | 0.664       | -3.6      | 52.6        | 7.020       | 16.9      | 157.5       | 0.038       | -28.4     | -8.3        | 0.429       | -7.4      | -59.4       | 1.245    |
| 0.90        | 0.607       | -4.3      | 38.9        | 7.769       | 17.8      | 137.0       | 0.042       | -27.5     | -26.6       | 0.379       | -8.4      | -88.7       | 1.204    |
| 1.00        | 0.558       | -5.1      | 25.8        | 8.334       | 18.4      | 117.4       | 0.045       | -26.9     | -43.8       | 0.340       | -9.4      | -117.1      | 1.178    |
| 1.10        | 0.511       | -5.8      | 13.4        | 8.791       | 18.9      | 98.9        | 0.048       | -26.4     | -61.1       | 0.309       | -10.2     | -143.6      | 1.158    |
| 1.20        | 0.472       | -6.5      | 1.6         | 9.137       | 19.2      | 80.9        | 0.050       | -26.1     | -76.6       | 0.286       | -10.9     | -169.0      | 1.147    |
| 1.30        | 0.435       | -7.2      | -10.2       | 9.413       | 19.5      | 63.7        | 0.051       | -25.8     | -92.4       | 0.265       | -11.5     | 167.3       | 1.140    |
| 1.40        | 0.403       | -7.9      | -21.3       | 9.626       | 19.7      | 46.9        | 0.052       | -25.6     | -107.2      | 0.251       | -12.0     | 145.0       | 1.131    |
| 1.50        | 0.372       | -8.6      | -32.5       | 9.773       | 19.8      | 30.7        | 0.053       | -25.5     | -121.4      | 0.237       | -12.5     | 124.1       | 1.131    |
| 1.60        | 0.346       | -9.2      | -42.9       | 9.882       | 19.9      | 14.8        | 0.054       | -25.4     | -135.6      | 0.225       | -12.9     | 104.4       | 1.132    |
| 1.70        | 0.318       | -9.9      | -53.3       | 9.992       | 20.0      | -1.0        | 0.054       | -25.4     | -149.5      | 0.216       | -13.3     | 85.6        | 1.133    |
| 1.80        | 0.296       | -10.6     | -62.6       | 10.040      | 20.0      | -16.4       | 0.054       | -25.4     | -163.2      | 0.205       | -13.8     | 67.3        | 1.138    |
| 1.90        | 0.274       | -11.3     | -71.6       | 10.066      | 20.1      | -31.6       | 0.054       | -25.3     | -176.0      | 0.193       | -14.3     | 49.9        | 1.143    |
| 2.00        | 0.253       | -12.0     | -79.9       | 10.101      | 20.1      | -46.7       | 0.054       | -25.3     | 170.4       | 0.184       | -14.7     | 33.7        | 1.145    |
| 2.10        | 0.237       | -12.5     | -87.0       | 10.090      | 20.1      | -61.6       | 0.054       | -25.3     | 157.8       | 0.174       | -15.2     | 17.1        | 1.149    |
| 2.20        | 0.221       | -13.1     | -94.0       | 10.079      | 20.1      | -76.4       | 0.054       | -25.4     | 145.0       | 0.164       | -15.7     | 1.8         | 1.158    |
| 2.30        | 0.210       | -13.6     | -98.8       | 10.056      | 20.1      | -91.1       | 0.054       | -25.4     | 131.7       | 0.154       | -16.3     | -13.4       | 1.165    |
| 2.40        | 0.204       | -13.8     | -103.1      | 9.969       | 20.0      | -105.7      | 0.053       | -25.5     | 119.4       | 0.144       | -16.8     | -27.1       | 1.179    |
| 2.50        | 0.204       | -13.8     | -107.9      | 9.922       | 20.0      | -120.2      | 0.053       | -25.6     | 107.0       | 0.133       | -17.5     | -41.6       | 1.183    |
| 3.00        | 0.254       | -11.9     | -134.8      | 9.361       | 19.4      | 168.2       | 0.049       | -26.3     | 45.9        | 0.075       | -22.5     | -89.7       | 1.247    |
| 3.50        | 0.352       | -9.1      | -178.6      | 8.510       | 18.6      | 98.1        | 0.043       | -27.3     | -12.9       | 0.084       | -21.5     | -79.3       | 1.338    |
| 4.00        | 0.448       | -7.0      | 129.0       | 7.488       | 17.5      | 29.9        | 0.037       | -28.7     | -68.6       | 0.181       | -14.8     | -117.4      | 1.488    |
| 5.00        | 0.582       | -4.7      | 14.5        | 5.425       | 14.7      | -100.9      | 0.028       | -31.2     | -170.5      | 0.358       | -8.9      | 130.6       | 1.885    |
| 6.00        | 0.677       | -3.4      | -104.3      | 3.873       | 11.8      | 135.0       | 0.023       | -32.8     | 97.5        | 0.431       | -7.3      | 16.2        | 2.316    |
| 7.00        | 0.749       | -2.5      | 139.9       | 2.729       | 8.7       | 15.0        | 0.023       | -32.9     | 8.0         | 0.467       | -6.6      | -99.4       | 2.491    |
| 8.00        | 0.787       | -2.1      | 30.3        | 1.913       | 5.6       | -99.7       | 0.022       | -33.1     | -90.8       | 0.495       | -6.1      | 146.2       | 3.046    |
| 9.00        | 0.799       | -2.0      | -75.6       | 1.398       | 2.9       | 148.5       | 0.024       | -32.3     | 173.1       | 0.526       | -5.6      | 36.4        | 3.452    |
| 10.00       | 0.794       | -2.0      | 178.9       | 1.046       | 0.4       | 38.7        | 0.026       | -31.6     | 71.8        | 0.549       | -5.2      | -70.1       | 4.257    |
| 11.00       | 0.797       | -2.0      | 70.7        | 0.812       | -1.8      | -70.3       | 0.028       | -31.0     | -30.6       | 0.546       | -5.3      | -173.8      | 5.165    |
| 12.00       | 0.816       | -1.8      | -37.9       | 0.629       | -4.0      | -179.6      | 0.030       | -30.6     | -136.3      | 0.526       | -5.6      | 78.1        | 6.052    |
| 13.00       | 0.827       | -1.7      | -139.4      | 0.470       | -6.6      | 72.4        | 0.029       | -30.9     | 116.0       | 0.535       | -5.4      | -35.5       | 7.992    |
| 14.00       | 0.829       | -1.6      | 125.2       | 0.358       | -8.9      | -28.5       | 0.024       | -32.4     | 27.4        | 0.567       | -4.9      | -146.5      | 11.988   |
| 15.00       | 0.801       | -1.9      | 22.2        | 0.311       | -10.1     | -134.6      | 0.029       | -30.7     | -80.8       | 0.601       | -4.4      | 110.9       | 12.115   |
| 16.00       | 0.790       | -2.1      | -91.7       | 0.249       | -12.1     | 113.3       | 0.030       | -30.4     | 166.6       | 0.619       | -4.2      | 4.7         | 14.902   |
| 17.00       | 0.810       | -1.8      | 162.7       | 0.163       | -15.8     | 0.5         | 0.025       | -32.2     | 50.9        | 0.661       | -3.6      | -111.2      | 23.713   |
| 18.00       | 0.824       | -1.7      | 68.3        | 0.071       | -22.9     | -99.0       | 0.013       | -37.6     | -50.7       | 0.728       | -2.8      | 130.8       | 79.608   |
| 19.00       | 0.820       | -1.7      | -27.4       | 0.047       | -26.6     | -95.2       | 0.007       | -43.2     | -78.2       | 0.788       | -2.1      | 12.8        | 193.344  |
| 20.00       | 0.809       | -1.8      | -130.0      | 0.152       | -16.3     | 151.9       | 0.033       | -29.7     | -165.6      | 0.676       | -3.4      | -103.2      | 19.267   |

## MGA-31816 Stability

$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$ ,  $Z_0 = 50\ \Omega$  (Data is de-embedded to the RFin & RFout pins on package. Measurements were made with Bias-T at  $V_{dd}$ ,  $V_{ctrl}$  and  $V_{bias}$  in Figure 48)

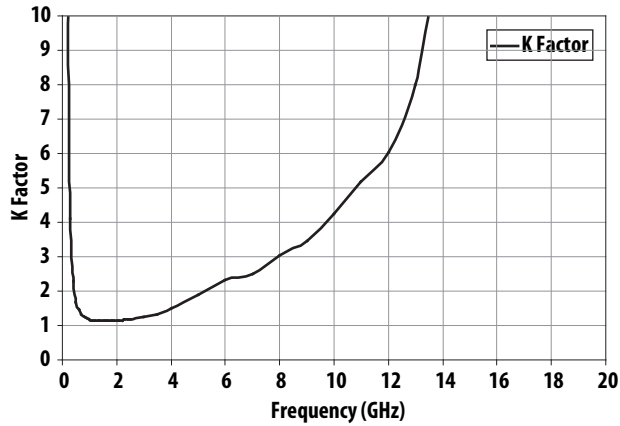


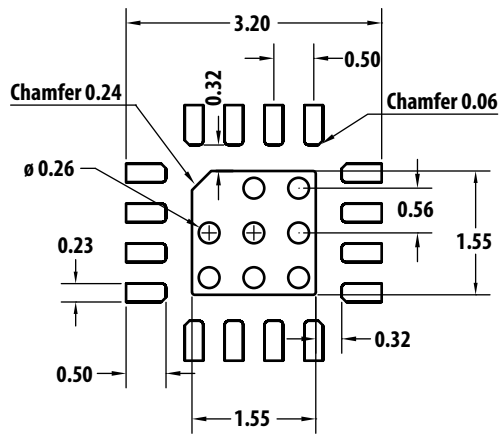
Figure 49. K-Factor vs Frequency

Table 5. MGA-31816 Typical Noise Parameters

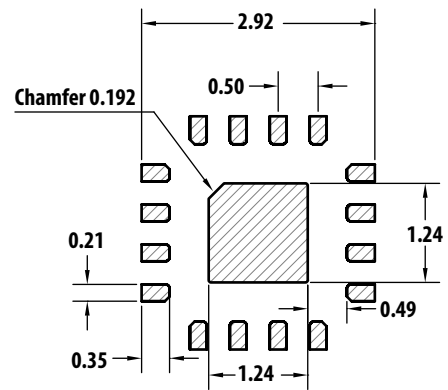
$T_C = 25^\circ\text{C}$ ,  $V_{dd} = 5.0\text{ V}$ ,  $I_{dd} = 60\text{ mA}$ ,  $Z_0 = 50\ \Omega$  (Data is de-embedded to the RFin & RFout pins on package. Measurements were made with Bias-T at  $V_{dd}$ ,  $V_{ctrl}$  and  $V_{bias}$  in Figure 48)

| Freq<br>(GHz) | $F_{min}$<br>(dB) | $\Gamma_{opt}$<br>Mag | $\Gamma_{opt}$<br>Ang | $R_n/Z_0$ | Ga<br>(dB) |
|---------------|-------------------|-----------------------|-----------------------|-----------|------------|
| 0.5           | 3.52              | 0.805                 | -152.5                | 0.2802    | 18.93      |
| 0.8           | 2.15              | 0.65                  | -142.8                | 0.181     | 20.34      |
| 0.9           | 1.92              | 0.617                 | -140.5                | 0.1648    | 20.50      |
| 1.0           | 1.79              | 0.586                 | -140.1                | 0.1554    | 20.61      |
| 1.5           | 1.44              | 0.49                  | -132.5                | 0.1278    | 20.85      |
| 2.0           | 1.35              | 0.425                 | -129.3                | 0.121     | 20.82      |
| 2.5           | 1.28              | 0.385                 | -125.1                | 0.118     | 20.65      |
| 3.0           | 1.29              | 0.35                  | -120.4                | 0.1202    | 20.43      |
| 3.5           | 1.35              | 0.38                  | -121.4                | 0.128     | 20.05      |
| 4.0           | 1.48              | 0.428                 | -119.9                | 0.1412    | 19.64      |
| 4.5           | 1.61              | 0.477                 | -118.1                | 0.151     | 19.22      |
| 5.0           | 1.82              | 0.552                 | -112.5                | 0.1782    | 18.80      |
| 5.5           | 2.02              | 0.599                 | -99.8                 | 0.203     | 18.39      |
| 6.0           | 2.22              | 0.635                 | -90.4                 | 0.2528    | 17.98      |

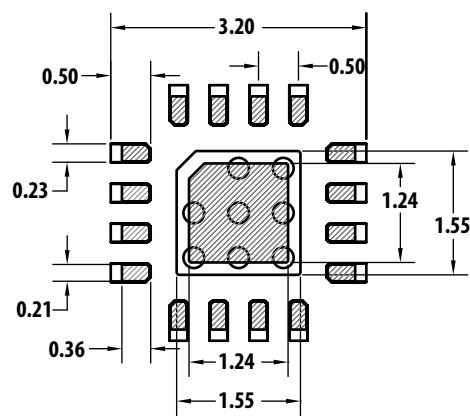
## PCB Layout and Stencil Design



**PCB LAND PATTERN (TOP VIEW)**



**STENCIL OUTLINE**

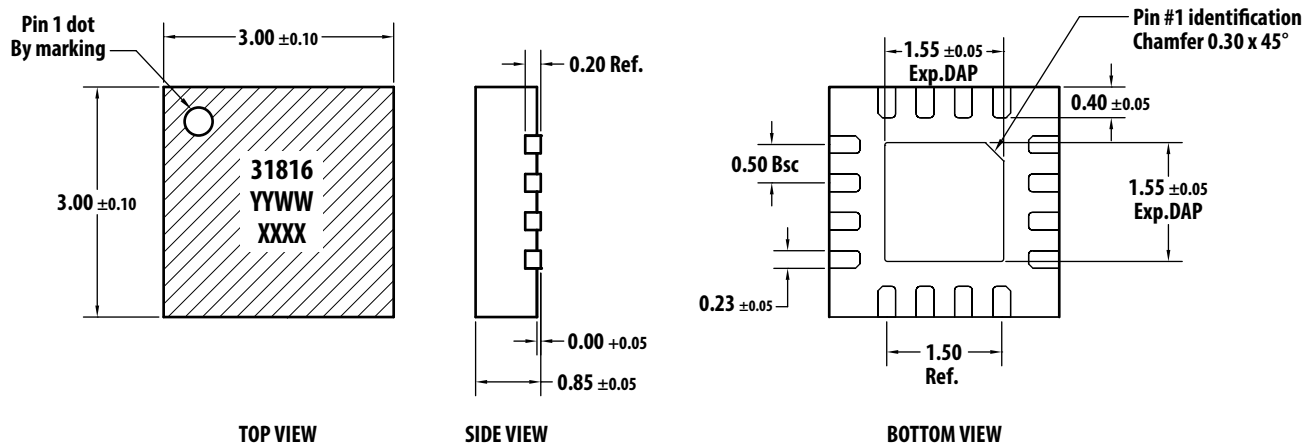


**COMBINED PCB & STENCIL LAYOUTS**

### Notes:

1. All dimensions are in millimeters
2. 4mil stencil thickness recommended

## Package Dimensions



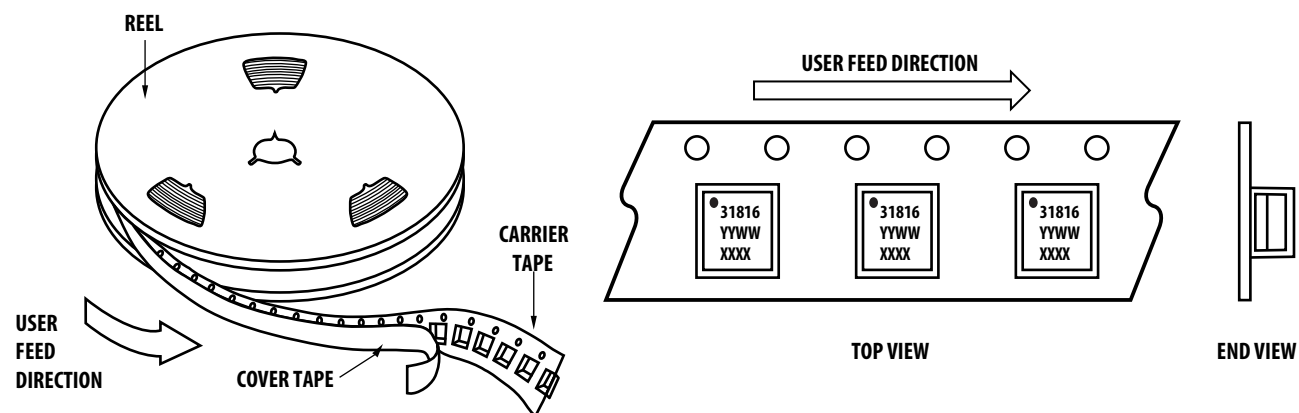
Notes:

1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold flash and metal burr.

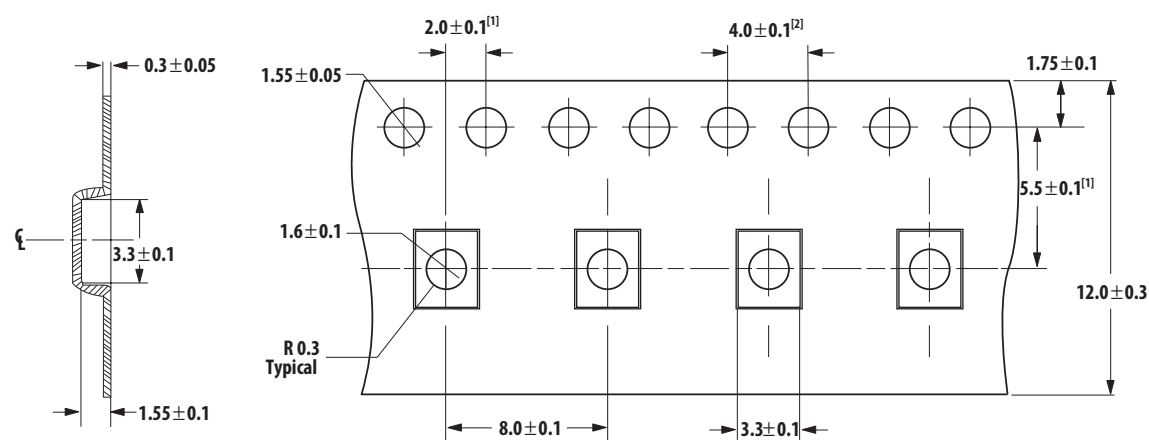
## Part Number Ordering Information

| Part Number    | No. of Devices | Container      |
|----------------|----------------|----------------|
| MGA-31816-BLKG | 100            | Antistatic Bag |
| MGA-31816-TR1G | 3000           | 13" Tape/Reel  |

## Device Orientation



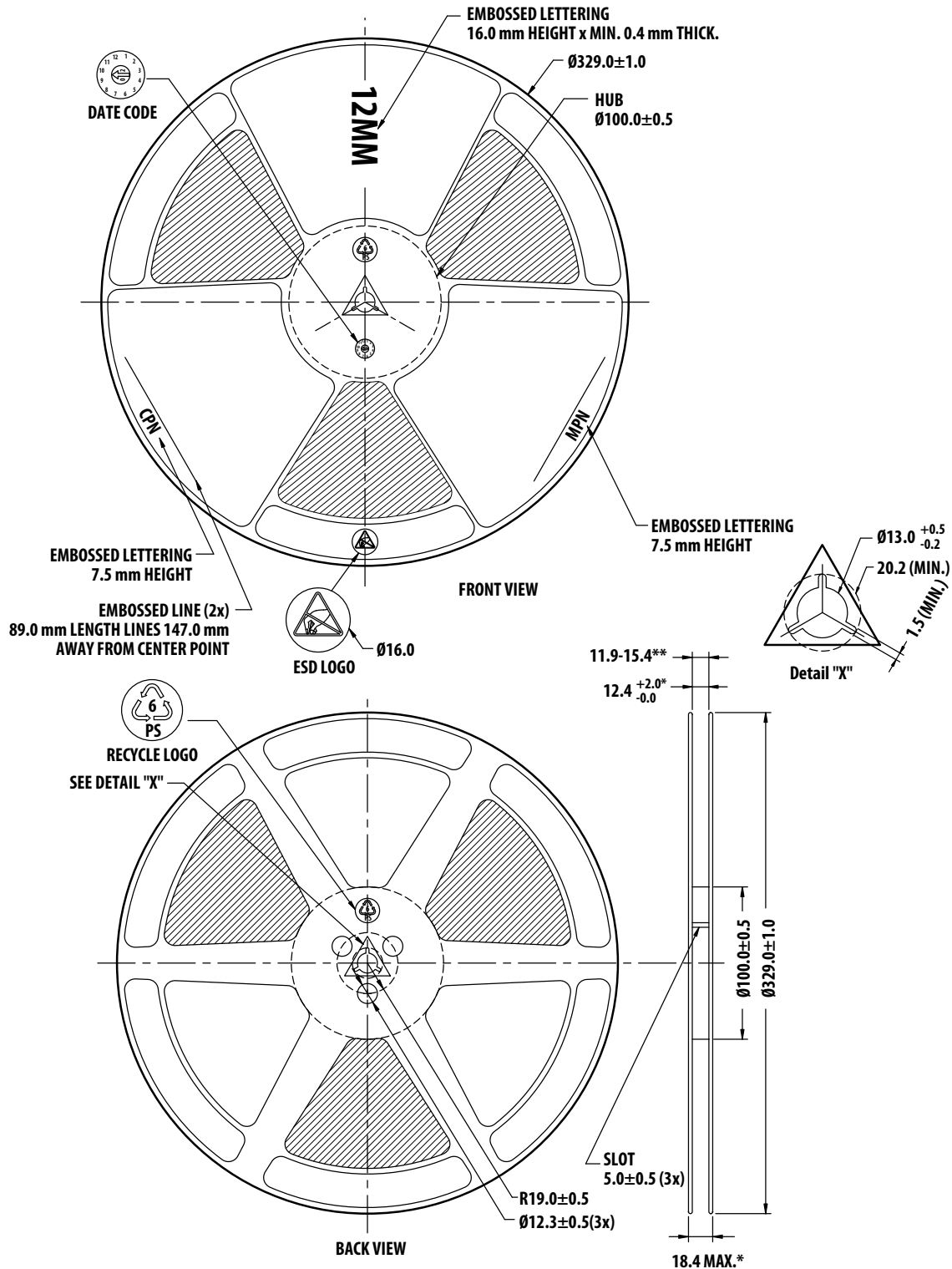
## Tape Dimensions



**Notes:**

1. Measured from centerline of sprocket hole to centerline of pocket
2. Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$
3. Other material available
4. All dimensions in millimeter unless otherwise stated

## Reel Dimension – 13" Reel 12 mm Width



For product information and a complete list of distributors, please go to our web site: [www.avagotech.com](http://www.avagotech.com)

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